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PROPOSAL FOR

A TRANSPORTABLE INFLATABLE ANTENNA SYSTEM

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Proposal For

A TRANSPORTABLE INFLATABLE ANTENNA SYSTEM

Section I

GENERAL

This is a proposal for the design and development of an inflatable antenna system for operation within the range of approximately 350 to 10,000 mc. The physical dimensions shall be such that the assembled antenna system will fit within the confines of a volume 7 feet high by 9 feet square. Within the prescribed frequency range of 350 mc to 10,000 mc, the VSWR shall not exceed 3:1. A beamwidth of two degrees is desired at 10 kmc and as near a minimum of two degrees as possible over the frequency range with side lobes at least 10 db down. Fifty-ohm unbalanced feed lines shall be used with the length of line not to exceed 40 feet. Both horizontal and vertical polarization will be required of the system. The lower frequency limit will be determined more precisely when a model can be tested to see at what frequency the polarization change-over occurs.

It is proposed at this time that two antennas be used to cover the desired frequency range, each antenna to consist of three major units; the primary antenna or feed, the reflector assembly, and the supporting structure. A 6.5-foot parabolic reflector will cover the range from 350 mc to 6000 mc, and a two-foot reflector will cover the range from 6 kmc to 10 kmc. They will be mounted side by side on a pedestal in such a manner that they may be rotated 360° within a circle nine feet in diameter. The over-all height of the system on the pedestal base will be approximately seven feet. The centerline heights of the two reflectors are approximately 44 inches and 71 inches above the floor. The base of the pedestal need not be fastened to the floor. No provision is made for elevation adjustment. The pedestal may also be mounted on the top of a guyed mast to raise the axis of the larger antenna to a height of 12 feet. Although this proposal is concerned with the design and development of two reflectors and two primary feed sources, an additional study will be made in an attempt to see whether one reflector and one primary feed can be utilized to cover the prescribed frequency range.

Section II
PRIMARY FEEDS

The primary feed source for the large reflector will employ a logarithmically periodic structure and an electromagnetic horn will be used as the primary feed for the small reflector. Fifty-ohm coaxial cable will be used to feed both primary sources with the horn being fed through a waveguide to coax adapter. The two polarizations required can be obtained by a rotating joint on the back of each primary feed. Beamwidth and side lobe level will govern in part the f/d ratio of the reflecting surfaces.

The two proposed primary feed sources to cover the prescribed frequency range are shown in figures 2-1 and 2-2. The logarithmically periodic structure and the horn will be mounted at the focal points of their respective reflectors. In particular, the periodic structure will be mounted with the apex at the focal point and the horn will be mounted with its phase center as near the focal point as necessary.

The periodic structure will be encased in a foam plastic block 20 x 20 x 12 inches. Assuming a low-frequency limit of 350 mc, the effect of the aperture block will cause a decrease in gain of not greater than 1 db as compared to the theoretical gain calculations. A rotatable coaxial connector will project from the center of the rear face of the block to permit changes of polarization. Attached to the center of the cover membrane by plastic snaps will be a Fiberglas reinforced housing into which the periodic structure may be placed. Polarization may be changed by sliding the block out, turning it 90 degrees and sliding it back into the housing. Outer corners of the housing will be guyed to the ring girder by nylon cords.

The characteristics of the periodic structure are such that the aperture of the reflector is illuminated with approximately a 12-db illumination taper. This in turn will keep the side lobes considerably below the prescribed 10-db level. Figure 1 shows the proposed periodic structure. This particular antenna has been given the name of solid tooth structure with the following parameters: τ ratio of .6, α, β, and ψ angles of 135°, 45° and 45° respectively. The angles are shown in the sketch of the antenna, and the τ ratio is obtained by taking the ratio of tooth B and tooth A or the ratio of any two adjacent teeth on the structure. Patterns and impedance characteristics of the periodic structure are essentially independent of frequency and will therefore maintain a constant illumination of the reflecting surface at all frequencies. The method of feeding the periodic structure is such that the currents on both halves of the antenna are in phase and balanced although they are fed directly from an unbalanced line.

For the 6-kmc to 10-kmc range, it is proposed that an electromagnetic horn be used as the primary feed source. Due to the narrow bandwidth in question for this small reflector, it was decided that the horn would suffice as the primary feed because of its simplicity as compared to the periodic structure. This feed will consist of a transition from coaxial cable to open-ended waveguide terminating in a short flare. A short section of coaxial cable will be an integral part of the horn assembly and will be used to place the rotatable connector on the axis of rotation. A circular flange around the waveguide portion will be retained in an annular ring to which supporting struts will be attached. The feed horn polarity may be changed by turning the horn within the annular ring to either of two detent determined positions. The supporting struts will in turn be mounted to the ring girder. Construction will be of light gage aluminum and the horn will be filled with plastic foam. The diameter of the mounting flange on the horn will be 2-1/2 inches or less and over-all length of the horn will be less than six inches.

Beamwidths of the horn will be such as to produce the desired illumination taper so the half-power beamwidths at 10 kmc will be as near 2° as possible. Calculated half-power beamwidths of the reflector vary from 3.3° at 10 kmc to 5.5° at 6 kmc using a 10-db illumination taper. The beamwidths can be adjusted by changing the illumination taper of the reflector so as to produce the desired 2° beamwidth and still maintain the desired side lobe level.

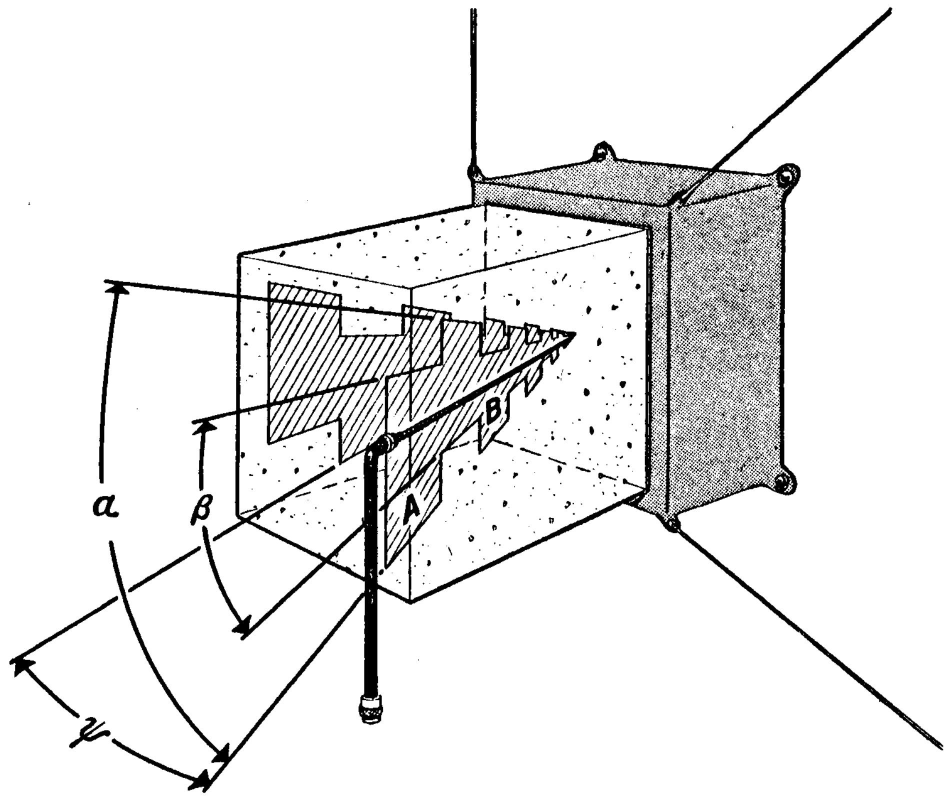

Figure 2-1. Feed Antenna for 6.5-Foot Reflector

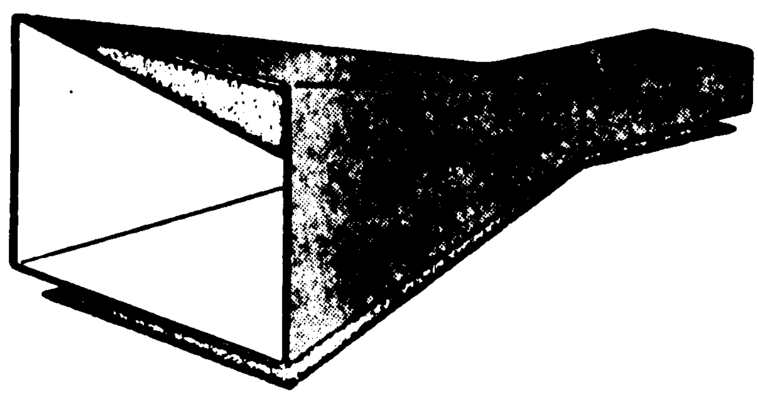

Figure 2-2. Feed Horn for 2-Foot Reflector

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Section III
REFLECTORS

Figure 3-1 shows a sketch of the inflatable reflectors. In each case the primary feed source will be mounted at the focal point of the reflecting surface. The f/d ratio of the large reflector will be .359 and for the small reflector it will be .40. These f/d ratios result from focal lengths of 28 and 9.6 inches, respectively. Expected gains for the large reflectors are 16 db at 350 mc and 39.7 db at 6 kmc. For the small reflector, the expected gains are 27 db at 6 kmc and 31 db at 10 kmc. These figures represent the gain over a half-wave dipole.

Each reflector assembly will consist of two membranes (a reflector membrane and a cover membrane) supported by an aluminum ring girder, held in place by an aluminum clamp ring, and inflated by a blower. The membranes are plastic coated Fiberglas cloth accurately fabricated to the desired contour when inflated to a predetermined pressure. Contour variations of both reflectors will be held to less than 1/16 of the minimum wavelength at which the particular reflector is used. The fabrics are assembled on the ring girder by putting grommets near their outer edges over smooth studs on the ring girder. The clamp ring is positioned over the fabrics and engaged with the studs in such a manner that location control guides on the fabrics force the clamp rings toward the ring girder, thus making a tighter air seal as pressure between the fabrics is increased. Handling loops are provided at the outer edge of each membrane. The cover membrane is transparent to r-f radiation but the reflector membrane is treated with a conductive coating to reflect the radiation. The membranes may be treated with a silicone compound to reduce the possibility of ice forming on the surface and to prevent a strong bond between the surface and the ice that may form. This ice can be removed by hitting the inflated membranes.

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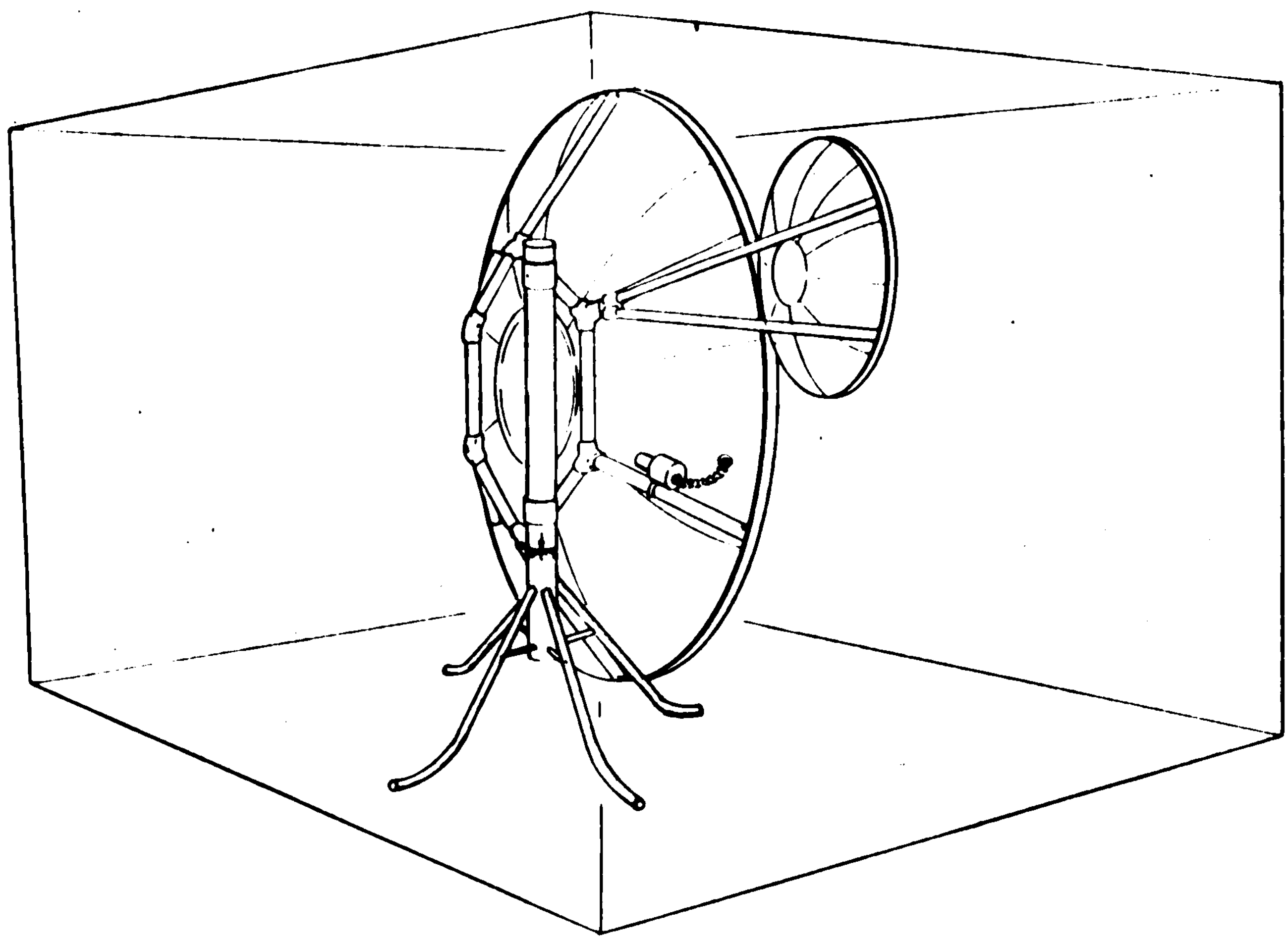

Figure 3-1. Inflatable Reflectors, Ground Level Mount

The large ring girder will be formed from aluminum channel in 18 identical sections designed for simple and rapid assembly. The smaller ring girder will be of similar construction but fewer parts. The studs used to retain the fabrics and clamp ring will present a smooth rounded surface to prevent snagging of the fabrics during assembly. The two reflector assemblies will be connected by a flexible air duct to require only one blower. Separate blowers are required for operation on 110/220 volt, 50 or 60 cycle, single-phase alternating current and for 12 volt direct current. These blowers will be multistage centrifugal blowers with integral electric motor. The blower will be mounted on the supporting structure near the lower edge of the reflector and connected to it by a flexible air duct.

It may also be possible to inflate the reflector assemblies with a foamed-in-place plastic which would harden in a short time and retain the form indefinitely. The membranes may be stripped from the foam and reused indefinitely. Approximately 100 pounds of plastic would be needed for both reflectors. This large volume of foamed-in-place plastic presents some difficulties in foaming technique and would require experimental work before we would know definitely that the procedure would be successful. The major problem with this process would be in mixing and pouring the large volume of highly viscous plastic.

Section IV
SUPPORTING STRUCTURE

The supporting structure for the antennas will consist of a tubular aluminum framework in the shape of a hexagon at the rear of the reflector and six radial struts between the corners of the hexagon and the ring girder. A large diameter tube is rigidly connected vertically across this hexagon and acts as a pivot for azimuth adjustment of the antenna. This tube will incorporate a clamp to maintain the desired azimuth pointing and an index mark to indicate the azimuth angle in degrees. The antenna may be mounted on a folding, four legged self-supporting pedestal for an over-all height of slightly less than seven feet or on a guyed mast for centerline heights of approximately six feet or twelve feet. The antenna, mounted on the guyed mast will be capable of operating in winds up to 60 mph and will be strong enough to survive in wind velocities up to 70 mph. The antenna mounted on the pedestal is illustrated in figure 3-1 and mounted on the guyed mast in figure 4-1. The mast will be built of aluminum tubing in three sections approximately 3 feet long. Guy wires of high tensile strength steel wire rope may be attached to the upper section and through turnbuckles to ground anchors of the arrowhead type which are capable of withstanding a pull of 5500 pounds in clay soil. The lower end of the mast will rest on a baseplate staked to the ground to give the mast torsional stability.

The smaller reflector will be connected tangentially to the ring girder of the larger reflector and additional stability will be gained from two struts braced between the small ring girder and one corner of the hexagonal frame behind the large reflector.

The entire structure, excluding the two mast sections, will be capable of being disassembled and packed in boxes 20 inches x 20 inches x 12 inches in outside dimensions. It is estimated that seven boxes will be required.

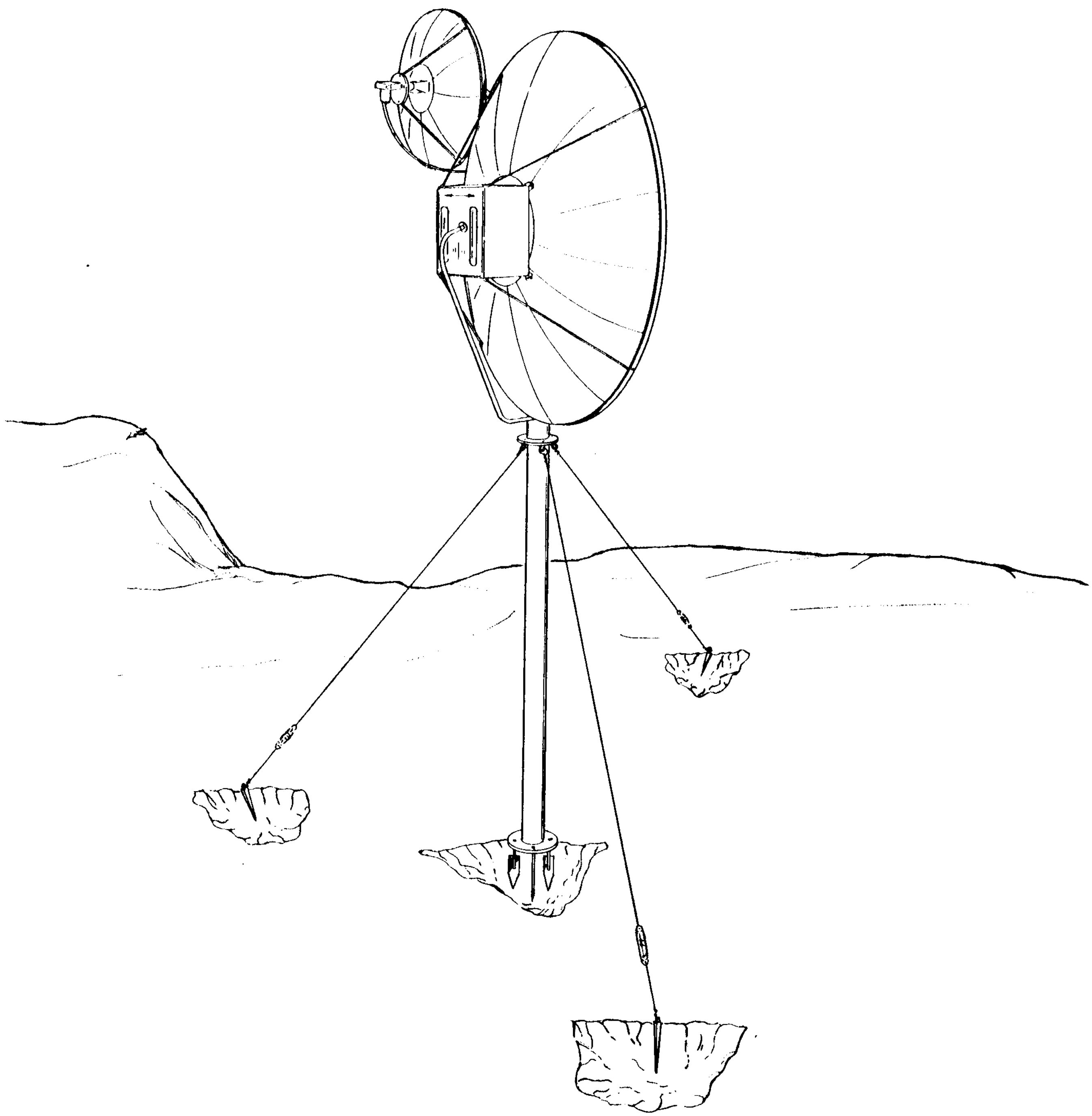

Figure 4-1. Inflatable Reflectors, Mast Mount

Section V
TRANSMISSION LINE

To satisfy the requirements of the transmission line, it is proposed that 1/2 inch OD 50-ohm Styroflex cable be used. Electrical characteristics show that at 10 kmc the attenuation for 35 feet of cable is 4.5 db. At 5 kmc and at 350 mc, the attenuation for 35 feet of cable is 2.75 db and .55 db, respectively.

The physical properties permit the cable to be handled quite easily for both installing and shipping purposes. The cable can be easily rolled into a diameter of one foot without destroying any of its characteristics. A total of 80 feet of cable will be supplied with each antenna. This cable will consist of two lengths of 24 feet and four lengths of 8 feet each.

All materials, finishes, and fabrication in these antennas will be in accordance with the best commercial practices.

Section VI
SPECIFICATION SUMMARY

Frequency Range:	350 - 6000 megacycles
Power Gain:	16 db at 350 mc to 39.7 db at 6000 mc
Beamwidth:	(Half power) 2° at 6 kmc to 29° at 350 mc
Side Lobes:	Below 10 db down
VSWR:	3:1 or less
Reflector:	Diameter - 6 feet 6 inches
	Focal length - 28 inches
Transmission Line:	1/2 inch 50 ohm Styroflex coaxial cable, 40 feet
Polarization:	Horizontal or vertical
Frequency Range:	6000 - 10,000 megacycles
Power Gain:	27 db at 6 kmc to 31 db at 10 kmc
Beamwidth:	(1/2 power) 5.5° at 6 kmc to 3.3° at 10 kmc (maximum values)
Side Lobes:	Below 10 db down
Polarization:	Horizontal or vertical
VSWR:	3:1 or less
Reflector:	Diameter - 24 inches
	Focal length - 9.6 inches
Transmission Line:	1/2 inch, 50 ohm Styroflex coaxial cable, 40 feet
General:	
Mounting:	On floor of structure 7 ft high x 9 ft square, axis height 44 inches
	On ground using guyed mast, axis height 6 ft, 9 ft, 12 ft
Azimuth Adjustment:	360 degrees, continuous, indicated in degrees
Elevation Adjustment:	None provided

Wind and Ice Loading Limit:	70 miles per hour wind
Power Requirement for Inflating Blower:	110/220 volts, 50-60 cps, single phase, a-c, 55 watts or 12 V d-c
Storage Volume:	Antennas without mast - 7.5 cu ft
	Mast 3.5 cu ft
	Total 11.0 cu ft
	Maximum Part Length - 19 inches
	Packed Dimensions - In boxes 20 inches square x 12 inches
Weight:	Antennas on Pedestal 76 pounds
	Mast with guys and anchors 36 pounds
	Total 112 pounds